Assessing Observational GV Constraints on Snow Microphysics

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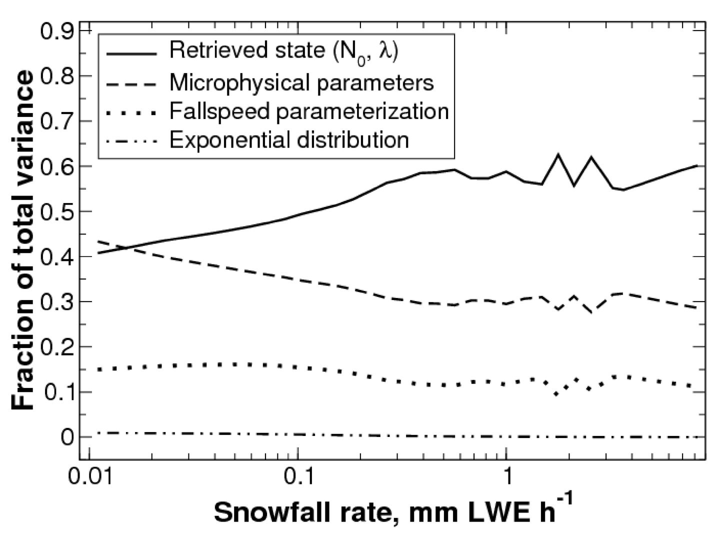
Overview

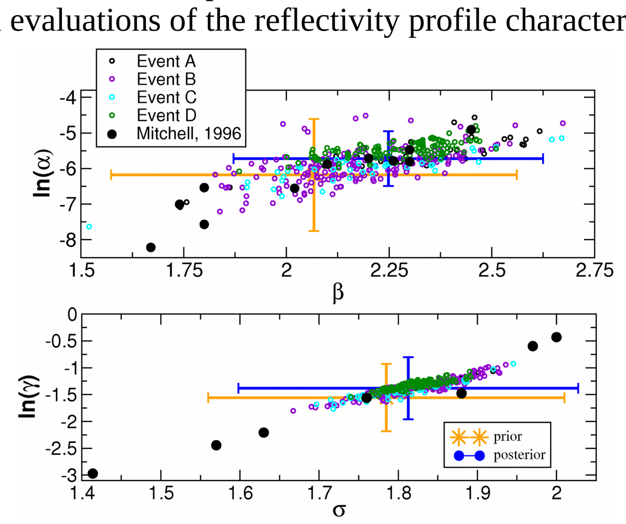
Assumptions about snow microphysical properties are essential to microwave-based remote sensing retrievals for snowfall. Sources of uncertainties in retrievals include assumptions about the form and shape (amplitude, slope) of the size distribution; estimates of particle fallspeeds; and parameterized relationships that describe particle masses, shapes and scattering properties. Among these, the most significant sources seem to be the size distribution shape and the microphysical properties:



This work seeks:

- to better quantify these assumed properties and their uncertainties, and
- to relate these quantities to properties that can be more directly measured with remote sensing observations.

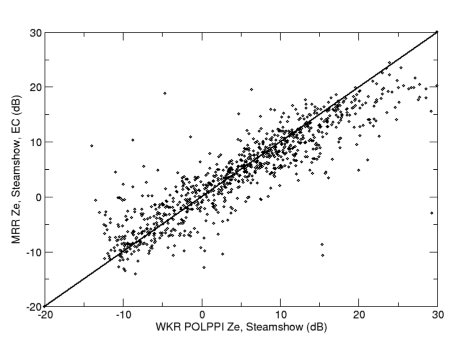
We use optimal estimation applied to intensive ground validation (GV) observations to assess the probability distribution functions for these properties and will relate these to observables such as vertical profiles of reflectivity and the thermal and humidity structure of the environment. The elements presented here describe assessments of optimal estimation inputs and initial evaluations of the reflectivity profile characteristics for several GV experiments.

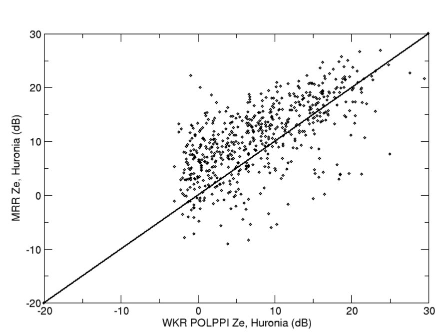


Vertically-profiling Radar Uncertainties

- Can ubiquitous K-band radars adequately approximate Rayleigh (m2) scattering for falling snow?

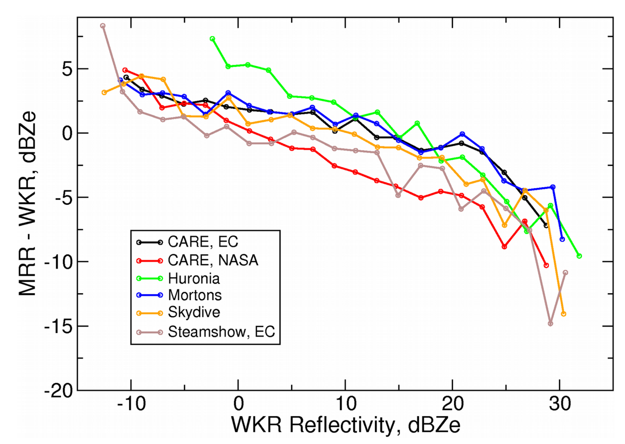
GCPEx MRR & WKR Observations

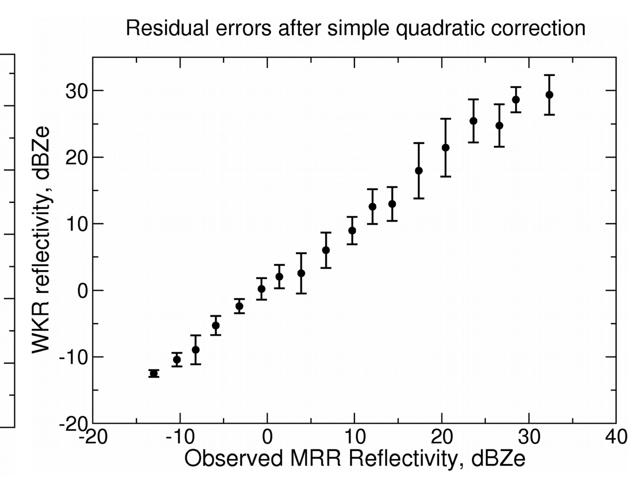




Vertically-profiling Radar Uncertainties, cont'd

We evaluate MicroRain Radar (MRR) measurements against collocated, well-calibrated C-band reflectivities from Environment Canada's King City radar. A simple quadratic corrects for bias and most residuals are comparable to previous evaluations for an X-band radar (1-3 dBZ).



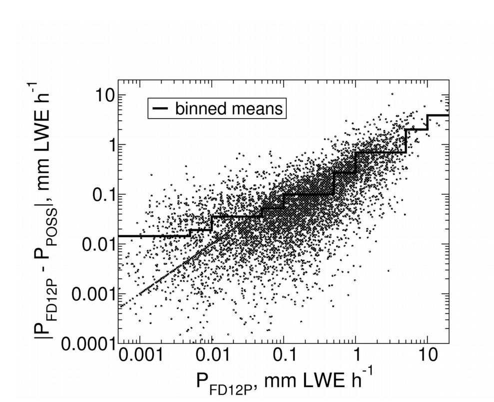


Precipitation Gauge Uncertainties

- Absent bias errors, how well do paired, ~collocated gauge measurements reproduce each other?

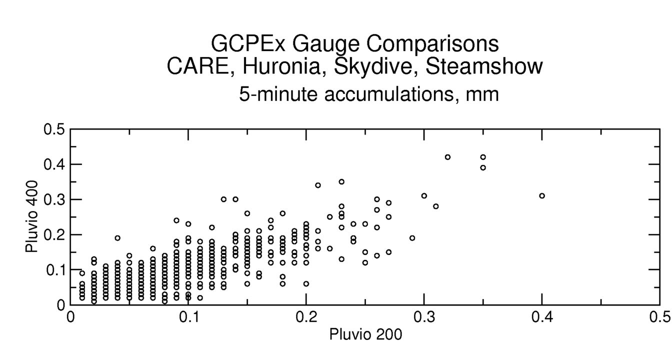
We evaluate departures of paired gauge measurements from an assumed 1:1 relationship and find that GV observations (Pluvio, FD12P) compare favorably with a well-instrumented multi-gauge installation (DFIR-type, Haukeliseter).

C3VP

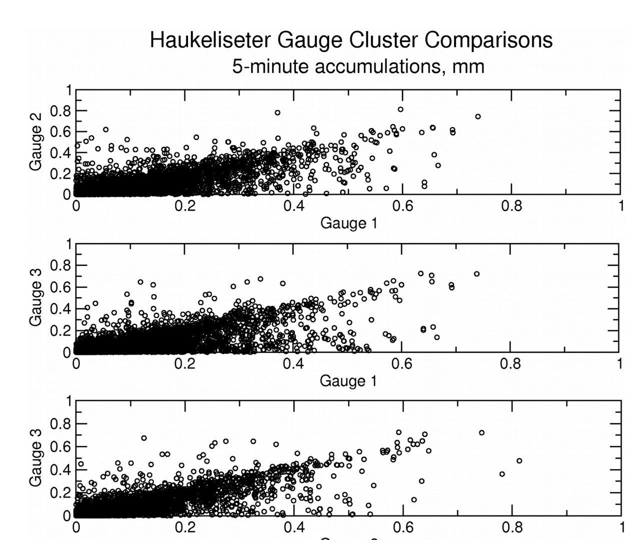


Site	Mean fractional error, % (mean accumulation, mm)
GCPEx	
CARE	26.8 (0.068)
Huronia	27.5 (0.069)
Skydive	30.6 (0.089)
Steamshow	27.9 (0.063)
C3VP	33.3 (0.047)
Haukeliseter	
Pair 1, 2	49.6 (0.089)
Pair 1, 3	54.5 (0.085)
Pair 2, 3	49.9 (0.076)

GCPEx



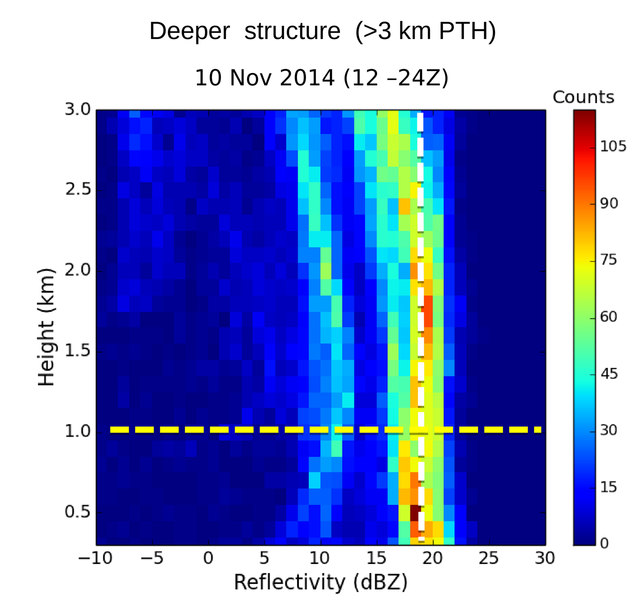
Haukeliseter (Met Norway)

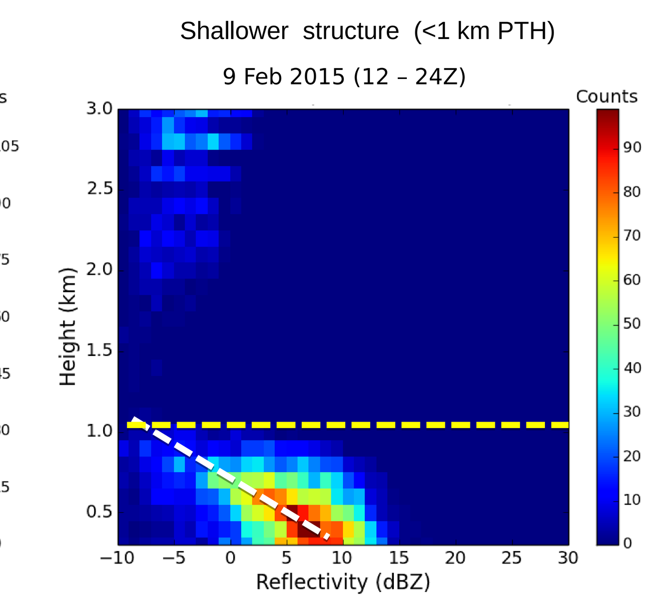


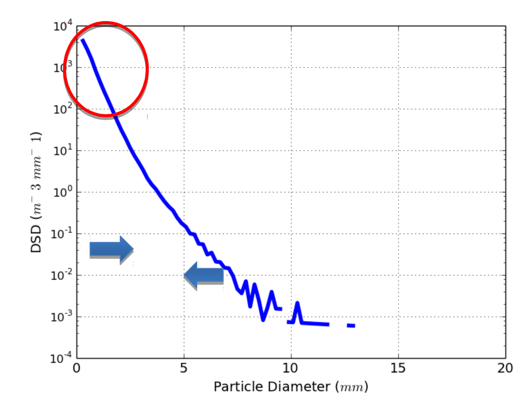
Linking Meteorology, Vertical Structure, Microphysics

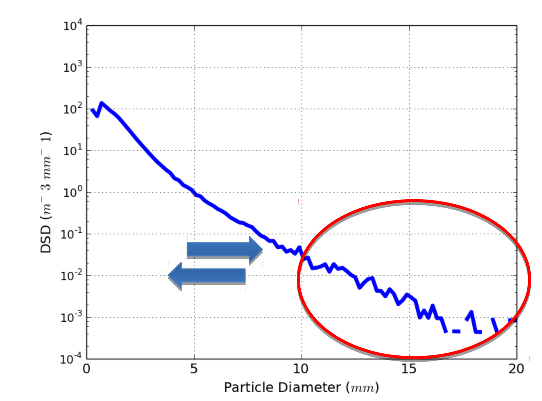
Marquette, MI Case Comparison

- Similar accumulations and duration (~8-10 inches)
- Differing vertical reflectivity structure
- Differing distributions of particle sizes at the ground



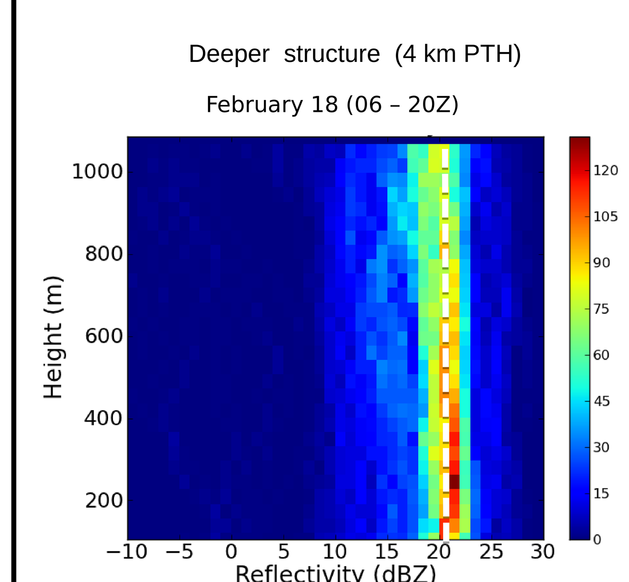


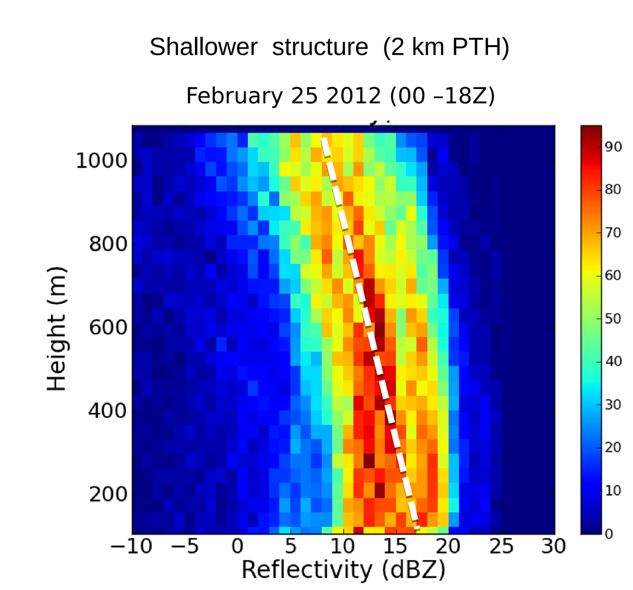


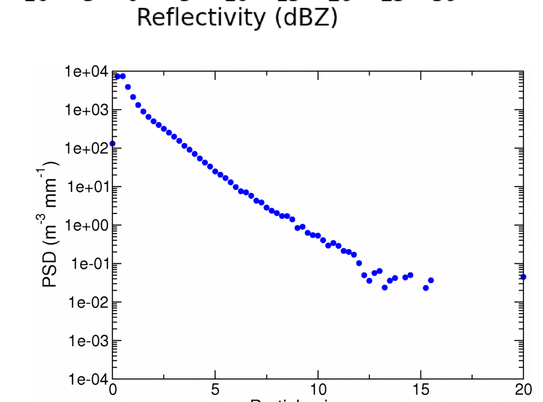


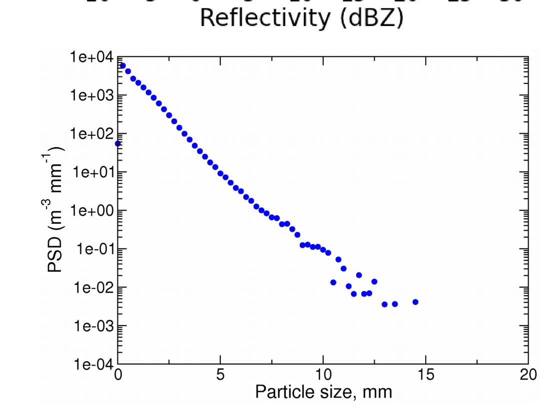
GCPEx Case Comparison

- Also similar accumulations and duration (~12 inches)
- Differing vertical reflectivity structure
- More similar distribution of particle sizes at the surface.



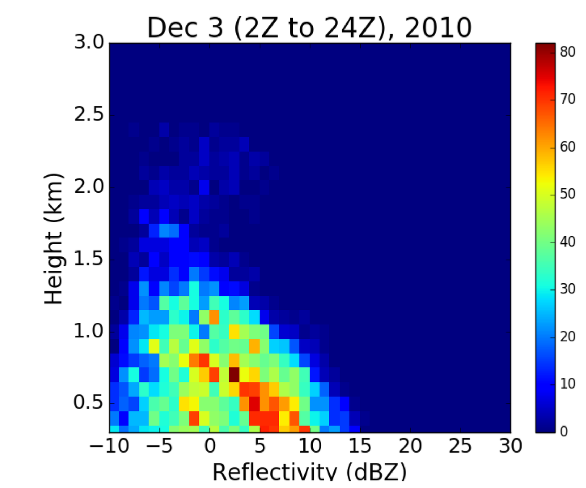




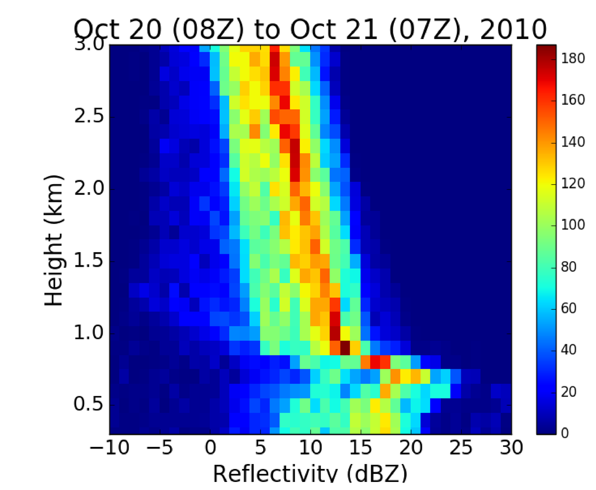


Linking Meteorology, Vertical Structure, Microphysics, continued

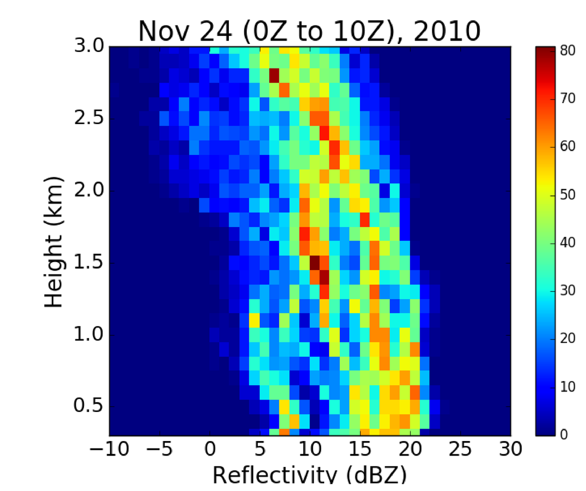
LPVEx-Jarvenpaa (Finland) Case Comparisons



- Shallow snow event
- Similar to Marquette shallow snow structure



- Uniform linear fall streaks in MRR time series (not shown). Low shear environment (?)
- Shallow melting level
- Possible mixed phase at ground.



- Deeper structure, but distinct from Marquette case.
- Irregular fall streaks in MRR time series (not shown). High shear environment (?)

Conclusions

- **In comparison to our previous X-band-derived estimates of microphysical properties, MRR observations should be an effective substitute.**
- **Similarly, the Pluvio gauges applied at GCPEx, LPVEx and other recent GV experiments show uncertainty characteristics similar to DFIR-like installation, assuming bias can be determined and corrected.**
- **This expands the potential GV sites and cases, allowing more varied meteorological regimes to be evaluated and related to the microphysical properties.**

Acknowledgments

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